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NAVY DEPARTMENT

THE DAVID W. TAYLOR MODEL BASIN

WASHINGTON 7, D.C.

COMPARISON OF FRICTIONAL RESISTANCE OF HOT PLASTIC AND VINYL RESIN ANTI-FOULING PAINTS FROM TRIALS OF FOUR DESTROYERS

FIFTH REPORT

TRIALS # 15 and # 16

By

George K. Brown

Prepared for
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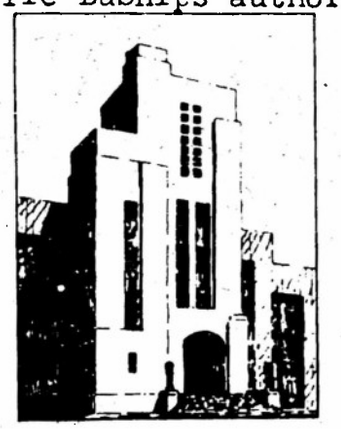

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Report No. C-474

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INTRODUCTION

The purpose of this report is to present the data for the fifth group of a series of trials initiated by the Bureau of Ships and the David Taylor Model Basin for an operational evaluation of two types of anti-fouling ship bottom paints. Trials were conducted on the USS KEPPLER (DDE765) and the USS NORRIS (DDE859) on the trial course at Rockland, Maine under the supervision of personnel from the David Taylor Model Basin assisted by personnel from the Boston Naval Shipyard (1), (2).*

Details of the preparation of the vessels for trials, their characteristics, the apparatus, methods of observing and analyzing the data, the model test conditions are presented in the initial report (3).

SHIP TRIAL CONDITIONS

These trials were conducted after the vessels had been out of drydock approximately 15 months. Standard conditions for the trials (3250 tons displacement and one foot trim by the stern) were maintained as closely as practicable. Propellers were inspected by a diver, just prior to trials, for possible damage and to determine whether cleaning was necessary. The diver's report of the propellers on the NORRIS (4) stated that the starboard propeller had sustained damage to three blades, but a later diver's report (5) stated that the propellers were found to be straight, clean and without nicks. On 17 October 1952 a diver inspected the propellers on the KEPPLER and reported that there was some damage to the port propeller (6). The KEPPLER was drydocked for a short period on 11 December 1952. At that time personnel from the Taylor Model Basin inspected the propellers and reported that the starboard propeller had several small kinks but nothing of any significance. The port propeller had not more than one or two kinks at the tips of the blades. Data for the trials are given in Table 1.

Numbers refer to references on page 6.

TABLE 1

SHIP TRIAL CONDITIONS

Trial Course: Rockland, Maine

Length of Trial Course: 6080 ft.

Depth of Water: 204 ft.

Wetted Surface (Standard condition): 18370 sq. ft.

Ship Name	KEPPLER		NORRIS	
Bottom Paint	Hot Plastic		Vinyl Resin	
Date of Trial	30 Oct	31 Oct	28 Oct	29 Oct
Displacement, tons	3260	3290	3340	3270
Mean Draft, ft.	13.76	13.83	13.98	13.77
Trim by Stern, in.	11	12	8	11
Days out of Dock	486	487	470	471
Temp. of Sea Water °F	53	53	52	52
Specific Gravity of Water	1.025	1.025	1.025	1.025
Wind (Beaufort Scale)	2	1 - 3	2 - 3	4

DISCUSSION OF TRIAL AND MODEL TEST RESULTS

The ship trials were carried out by making the usual three runs over the measured mile course at each of the approximate speeds of 14, 18, 20, 22, 24, 26, 28, 30, 31, 32 knots and at full power (approximately 60,000 SHP). Elapsed time over the mile, the propeller shaft torque, thrust and revolutions, and relative wind direction and velocity were recorded.

Power and RPM data from the trials are compared with the model test predictions in Figure 1 for the KEPPLER and in Figure 3 for the NORRIS. Two sets of SHP, THP and RPM curves derived from model tests are given in the figures, one set based upon the usual frictional resistance roughness allowance coefficient

(ΔC_f) of 0.0004 and the other based upon a roughness allowance of 0.00113 which corresponds to a condition of 12½ per cent increase in SHP at 30 knots over that given by the curves of 0.0004 roughness allowance. Curves of true advance coefficient (J_t), apparent advance coefficient (J_a), and speed of advance coefficient, average (1-w), and that from torque (1-w_Q) and thrust (1-w_t), identified separately, are compared for the ship and model in Figure 2 for the KEPPLER and in Figure 4 for the NORRIS. The faired trial data for each ship are compared in Table 2 with model test predictions. The speed of advance coefficients from torque and thrust are nearly identical, therefore, only the average value is given.

TABLE 2

Comparison of Ship Trial Results with Model Predictions at a Speed of 30 Knots.

Ship	KEPPLER		NORRIS	
Service Paint	Hot Plastic		Vinyl Resin	
ΔC_f model	0.0004	0.00113	0.0004	0.00113
$\frac{\text{SHP ship}}{\text{SHP model}}$	1.080	0.954	1.065	0.941
$\frac{\text{THP ship}}{\text{THP model}}$	1.112	0.976	1.077	0.945
$\frac{\text{RPM ship}}{\text{RPM model}}$	0.988	0.962	0.991	0.965
(1-w) ship	0.941	0.941	0.962	0.962
(1-w) model	1.002	1.013	1.002	1.013

COMPARISON OF SHIP TRIAL RESULTS

Curves of SHP, THP and RPM are presented separately in Figures 5 through 10 for each ship to illustrate the trend of the data with time out of dock. The faired data for each ship for the third service paint trials are compared with the zinc chromate trial data in Table 3 and with the data from the first service paint trials in Table 4 for a speed of 30 knots.

TABLE 3

Comparison of Service Paint Trial Results (15 Months out of Dock) with Zinc Chromate Trial Results at a Speed of 30 Knots.

Ship	KEPPLER	NORRIS
Service Paint	Hot Plastic	Vinyl Resin
$\frac{\text{SHP Service-15 mos.}}{\text{SHP Zn Cr}}$	1.097	+
$\frac{\text{THP Service-15 mos.}}{\text{THP Zn Cr}}$	1.097	1.052
$\frac{\text{RPM Service-15 mos.}}{\text{RPM Zn Cr}}$	1.006	1.006
(1-w) Service-15 mos.	0.941	0.962
(1-w) Zn Cr	0.969	0.968*

\+ Data not obtained for zinc chromate trials
* Thrust identity only

TABLE 4

Comparison of Service Paint Trial Results (15 Months out of Dock) with Service Paint Trial Results (0 Months out of Dock) at a Speed of 30 Knots.

Ship	KEPPLER	NORRIS
Service Paint	Hot Plastic	Vinyl Resin
$\frac{\text{SHP Service-15 mos.}}{\text{SHP Service-0 mos.}}$	1.050	1.078
$\frac{\text{THP Service-15 mos.}}{\text{THP Service-0 mos.}}$	1.039	1.052
$\frac{\text{RPM Service-15 mos.}}{\text{RPM Service-0 mos.}}$	0.997	1.006
(1-w) Service-15 mos.	0.941	0.962
(1-w) Service-0 mos.	0.968	0.968

It may be noted in Table 4 that the data from the trials with vinyl resin paint indicate a fouling rate which is greater than that for the hot plastic paint after 15 months out of dock. This trend is similar to that noted after the twelve month trials of the BERRY and McCAFFERY (7). The RPM of the NORRIS with vinyl resin paint has increased by 0.6 per cent during the fifteen month period while the KEPPLER with hot plastic has decreased 0.3 per cent during the same period. The BERRY with hot plastic paint did not demonstrate this trend of RPM at the end of twelve months (7) but showed an increase of 0.5 per cent.

Curves of frictional resistance coefficient, C_f, are presented in Figure 11 for the KEPPLER and in Figure 12 for the NORRIS. These figures show that C_f did not increase between the 9 and 15 months period for the hot plastic paint but increased approximately 0.0002 over the same period of time for the vinyl resin paint. At the time of these trials the frictional resistance coefficient for the hot plastic paint remained higher than that for the vinyl resin paint by approximately 5 per cent (0.00012). There was, however, a small difference in C_f between the two vessels at the outset i.e, during the zinc chromate trials, the basic resistance for the NORRIS was the highest. Taking this into account the increase in resistance coefficient over the zinc chromate condition for the hot plastic paint after 15 months was about 0.00055 whereas it was only 0.00035 for the vinyl resin which leaves a net difference of 0.0002 in increase in C_f in favor of vinyl resin.

REFERENCES

(1) BuShips ltr DDE/S19(436) over EN 8/A2-6 Serial 430-94 of 27 March 1951.

(2) BuShips ltr DDE/S19(436) over EN 8/A2-6 Serial 430-630 of 31 October 1951.

(3) TMB CONFIDENTIAL Report No. C-470 entitled "Comparison of Frictional Resistance of Hot Plastic and Vinyl Resin Anti-Fouling Paints from Trials of Four Destroyers, First Report, Trials #1 through #8", by C.J. Wilson dtd April 1952.

(4) Commanding Officer YELLOWSTONE ltr AD27/S44/JRC:bn Serial 345 of 21 March 1952.

(5) Commanding Officer USS ARCADIA ltr AD23/RO:wb Serial 816 of 22 October 1952.

(6) Commanding Officer USS ARCADIA ltr AD23/RO:wb Serial 818 of 22 October 1952.

(7) TMB CONFIDENTIAL Report No. C-473 entitled "Comparison of Frictional Resistance of Hot Plastic and Vinyl Resin Anti-Fouling Paints from Trials of Four Destroyers, Fourth Report, Trials #13 and #14", by C.J. Wilson dtd October 1952.

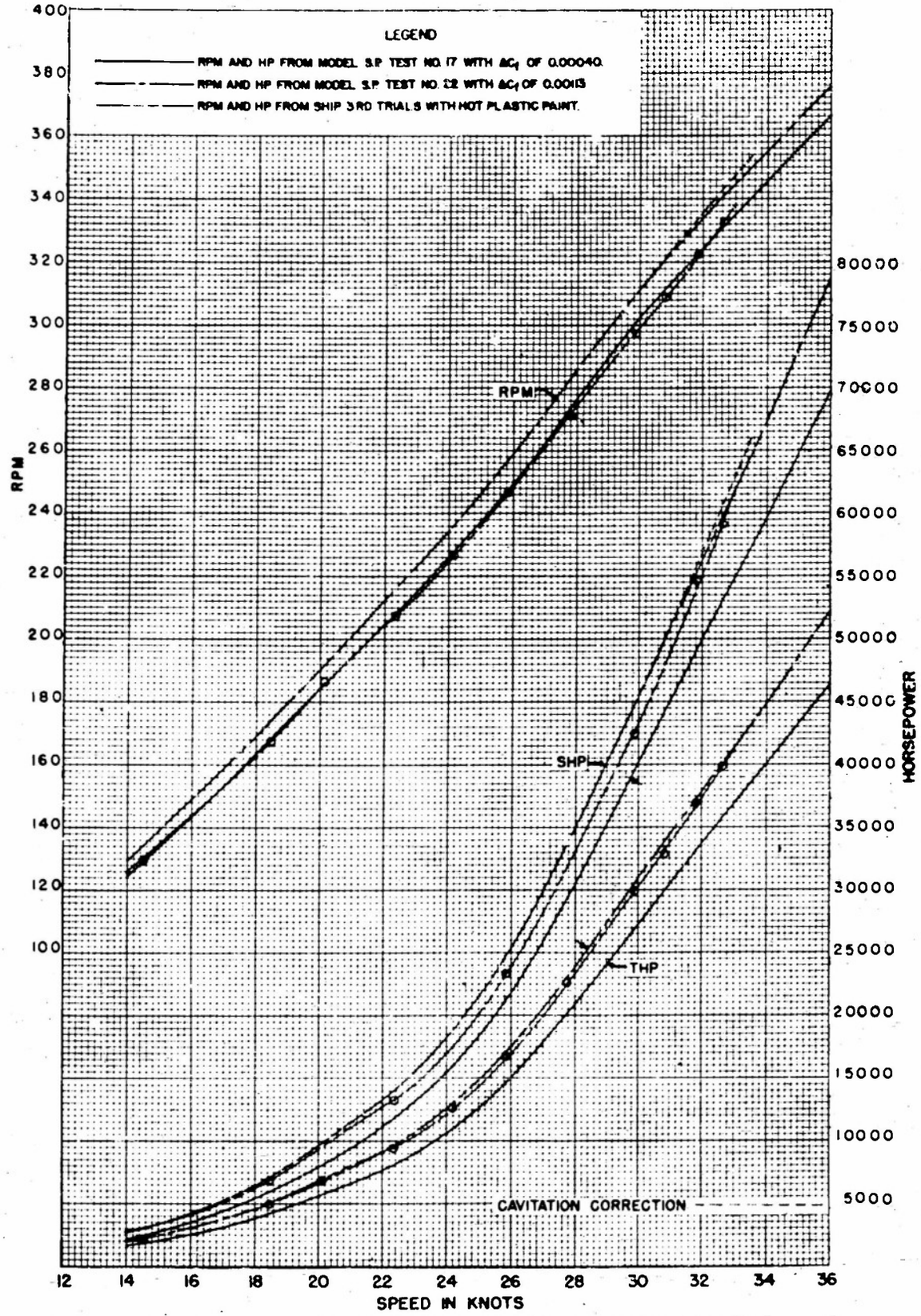

Figure 1 - Power and RPM Curves from Third Trials of USS KEPPLER (DDE 765) with Hot Plastic Paint Compared with Tests of Model 3878

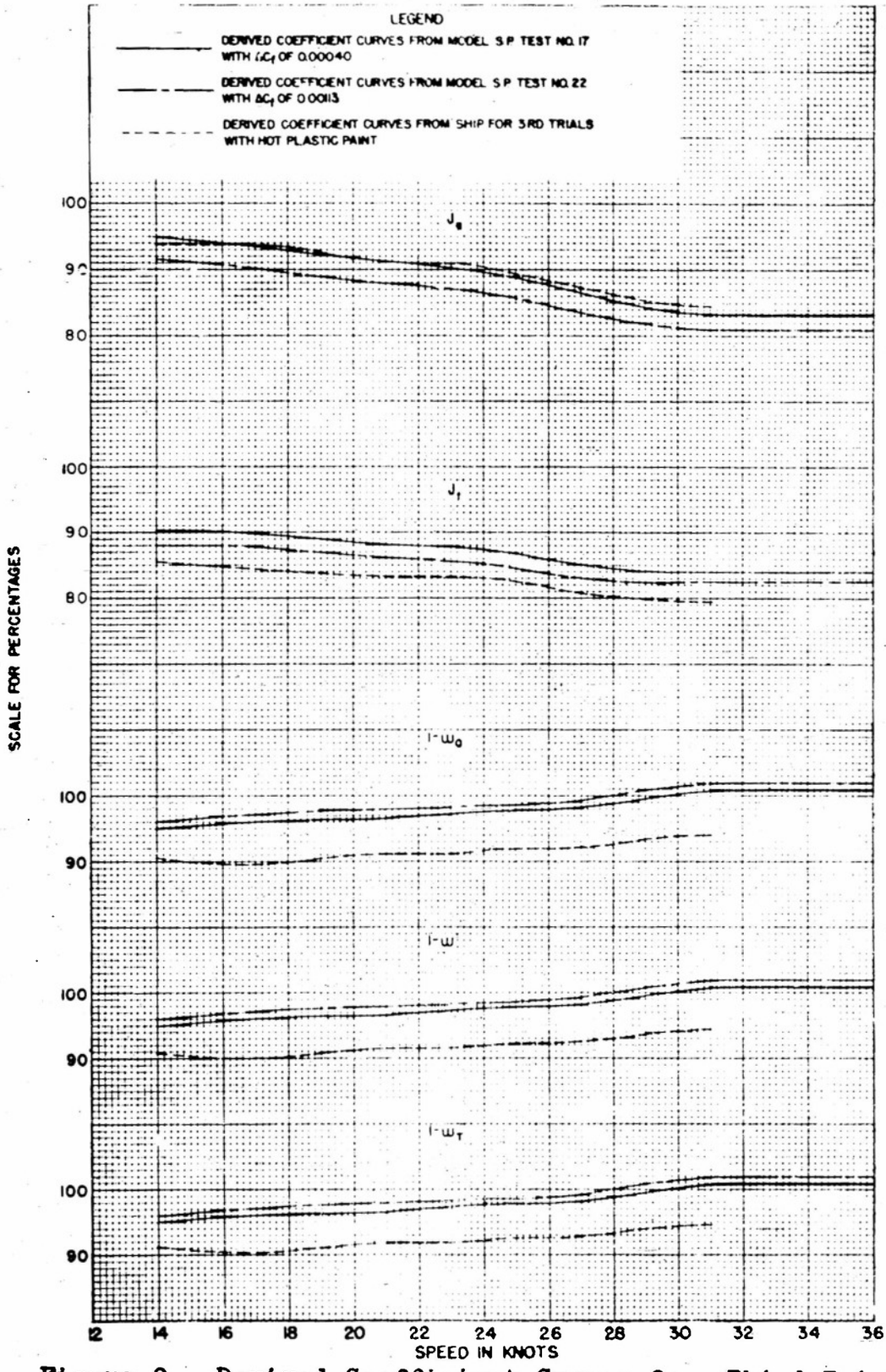

Figure 2 - Derived Coefficient Curves from Third Trials of the USS KEPPLER (DDE 765) with Hot Plastic Paint Compared with Tests of Model

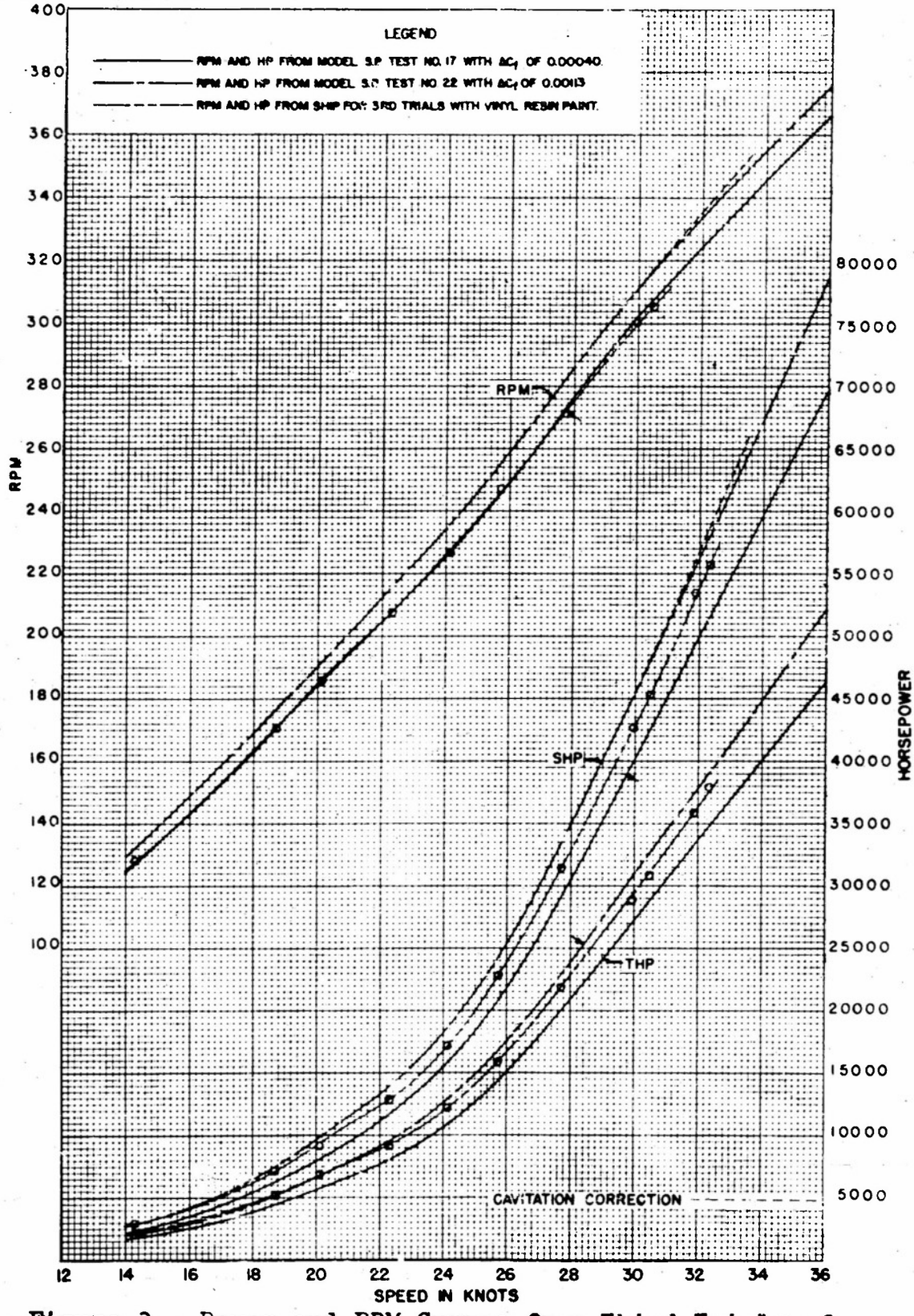

Figure 3 - Power and RPM Curves from Third Trials of USS NORRIS (DDE 859) with Vinyl Resin Paint Compared with Tests of Model 3878-1.

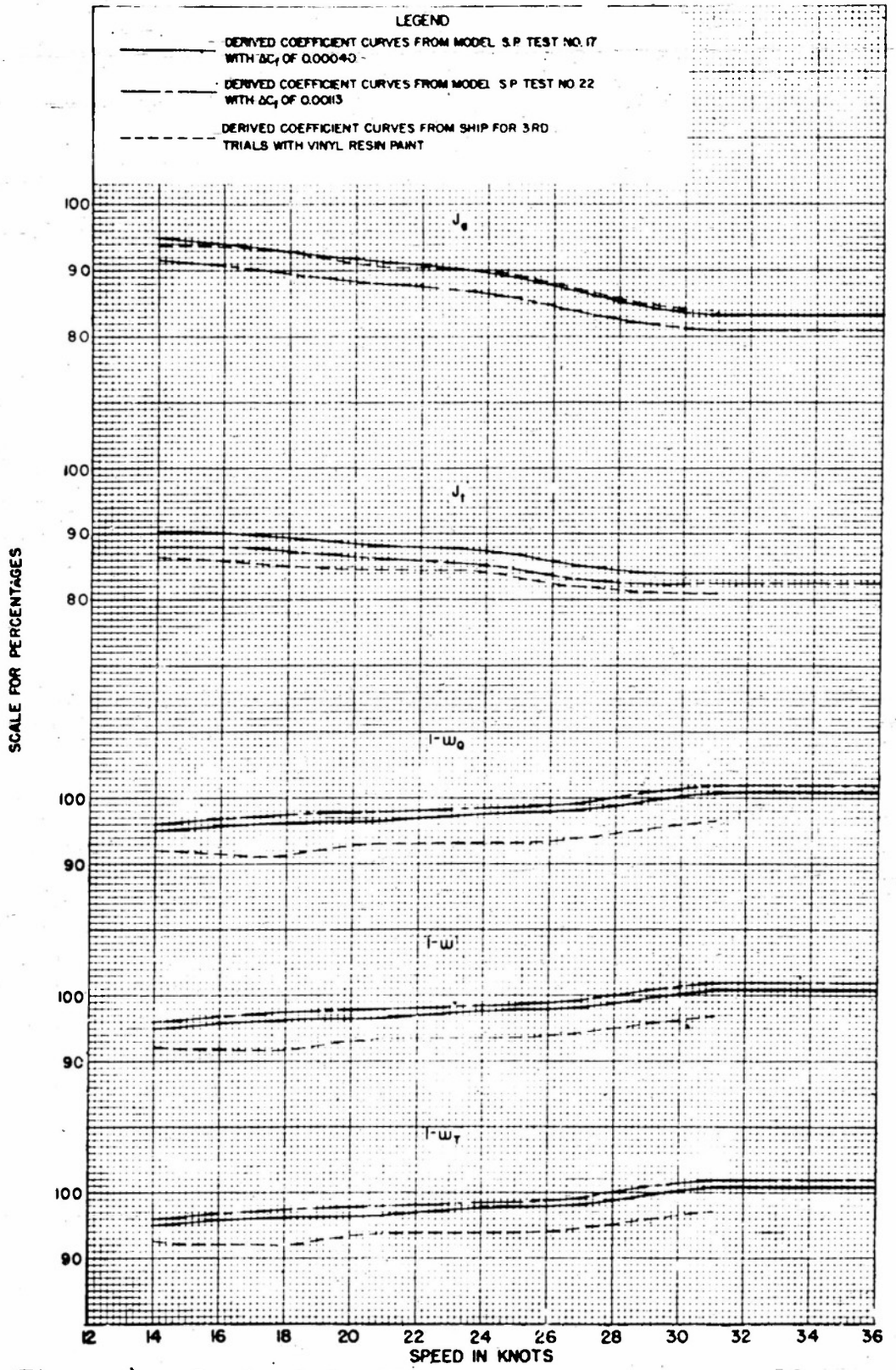

Figure 4 - Derived Coefficient Curves from Third Trials of USS NORRIS (DDE 859) with Vinyl Resin Paint Compared with Tests of Model 3878-1.

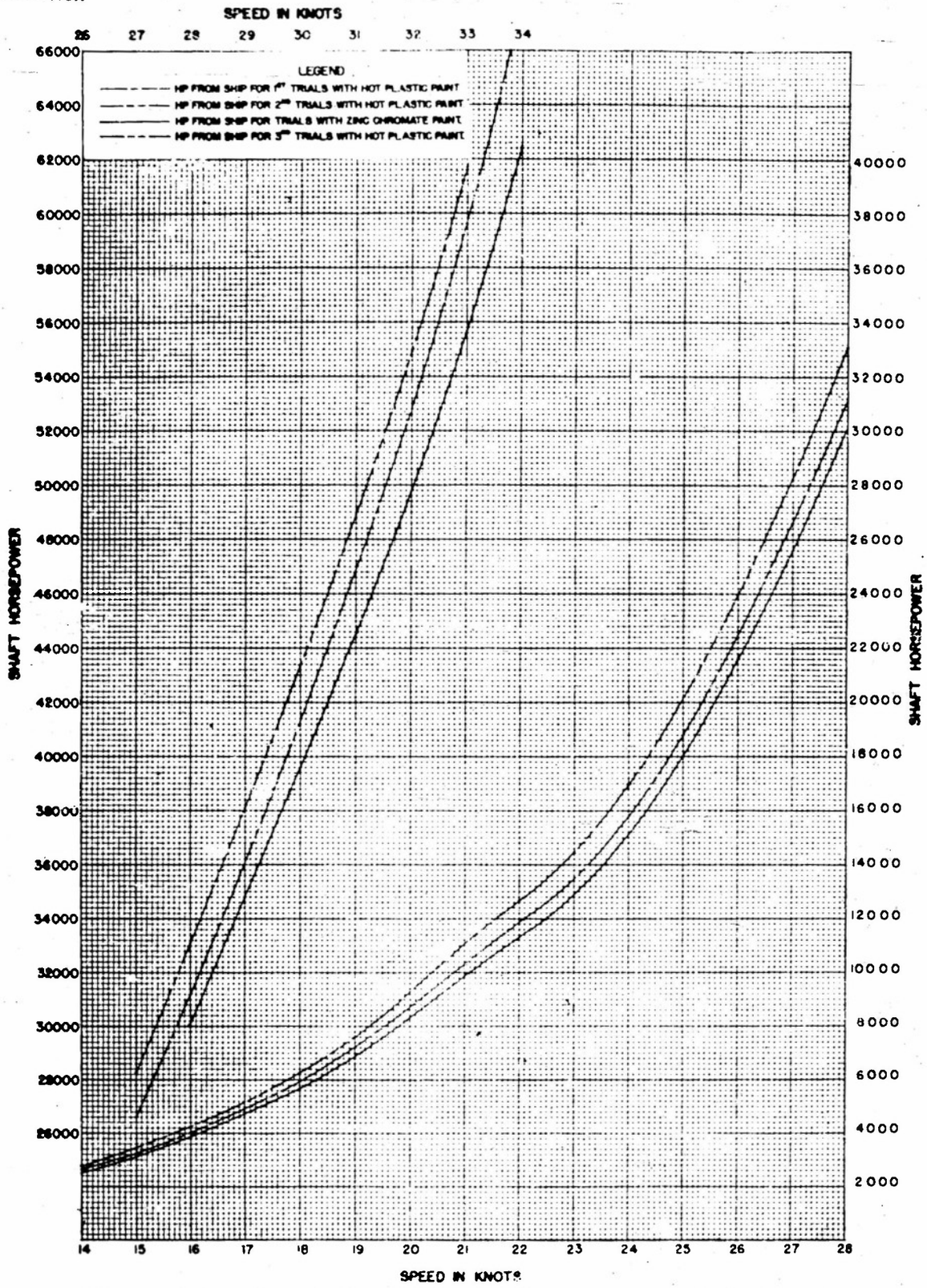

Figure 5 - Shaft Horsepower Curves from Trials of USS KEPPLER (DDE 765) with Hot Plastic & Zinc Chromate Paints Showing Trend of Data.

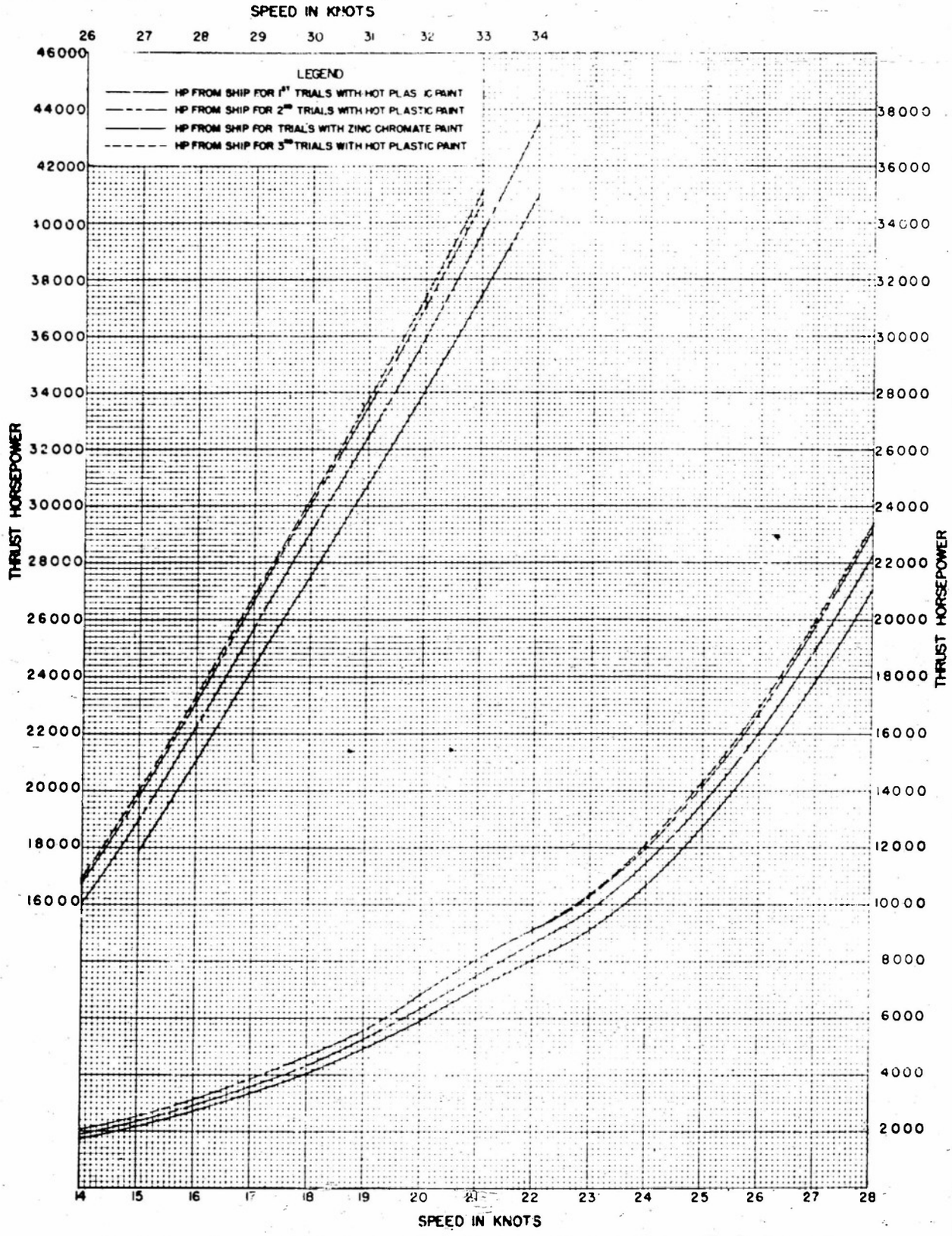

Figure 6 - Thrust Horsepower Curves from Trials of USS KEPPLER (DDE 765) with Hot Plastic & Zinc Chromate Paints Showing Trend of Data.

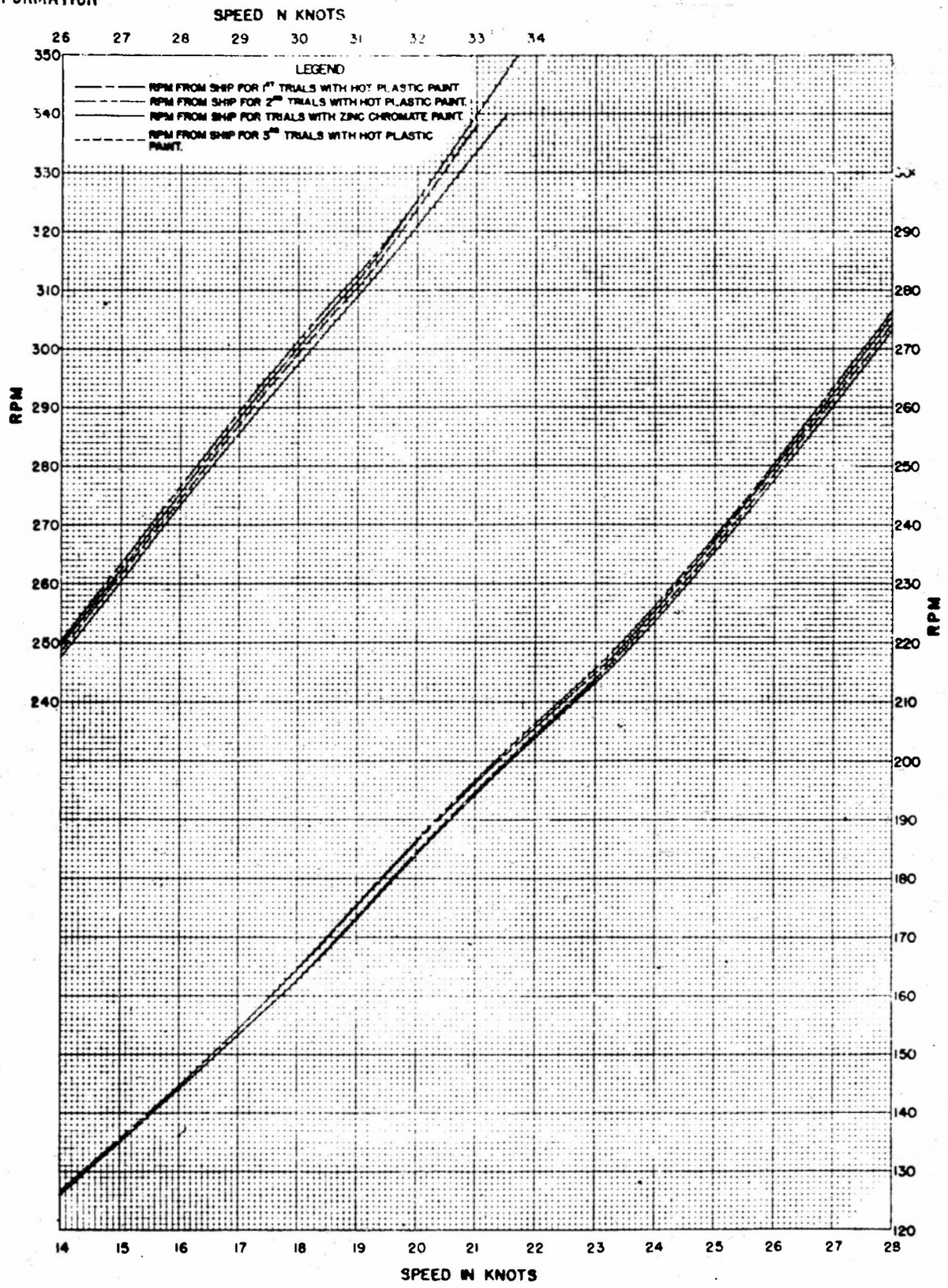

Figure 7 - RPM Curves from Trials of USS KEPPLER (DDE 765) with Hot Plastic & Zinc Chromate Paints Showing Trend of Data.

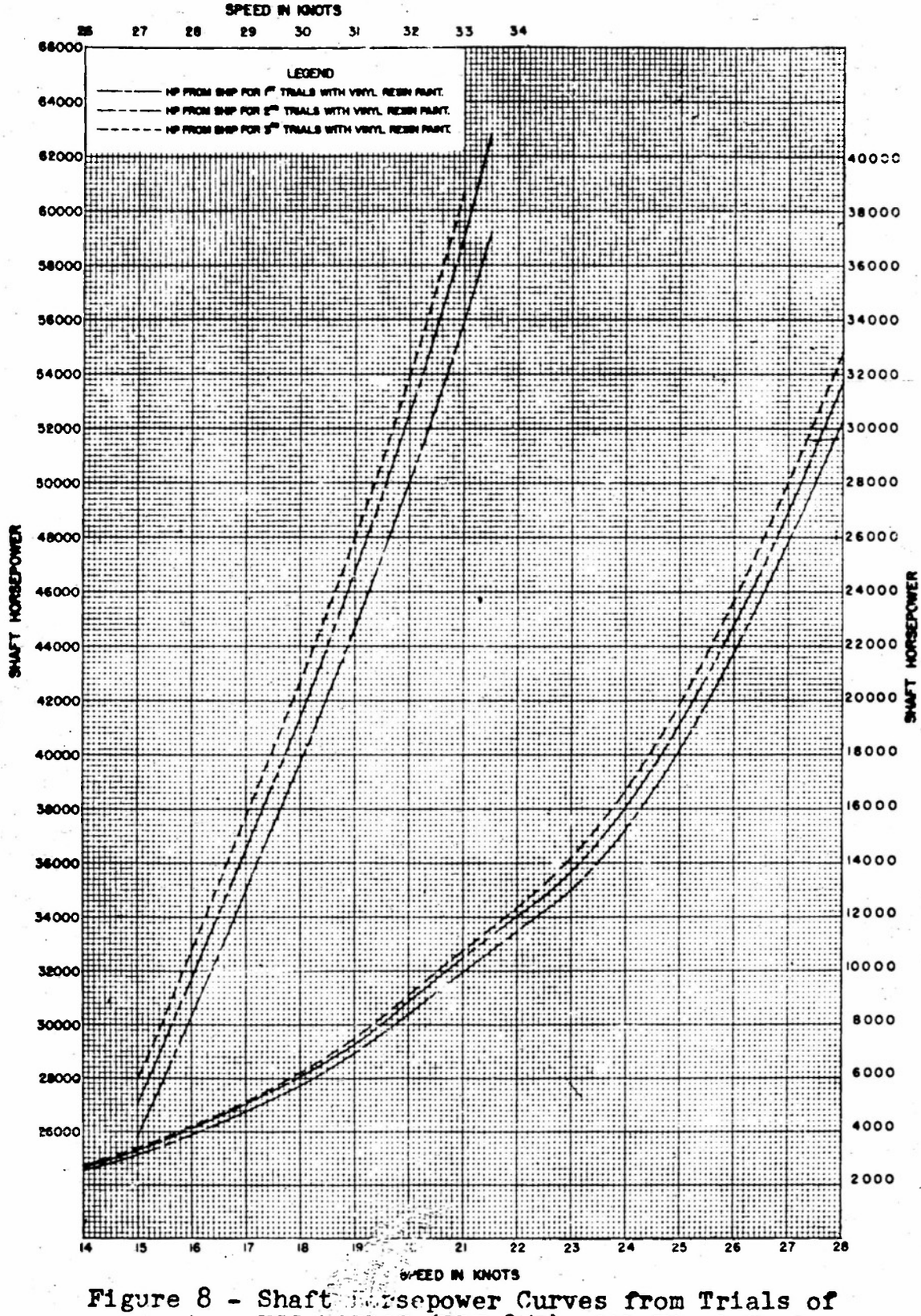

Figure 8 - Shaft Horsepower Curves from Trials of USS MORRIS (DDE 859) with Vinyl Resin Paints Showing Trend of Data.

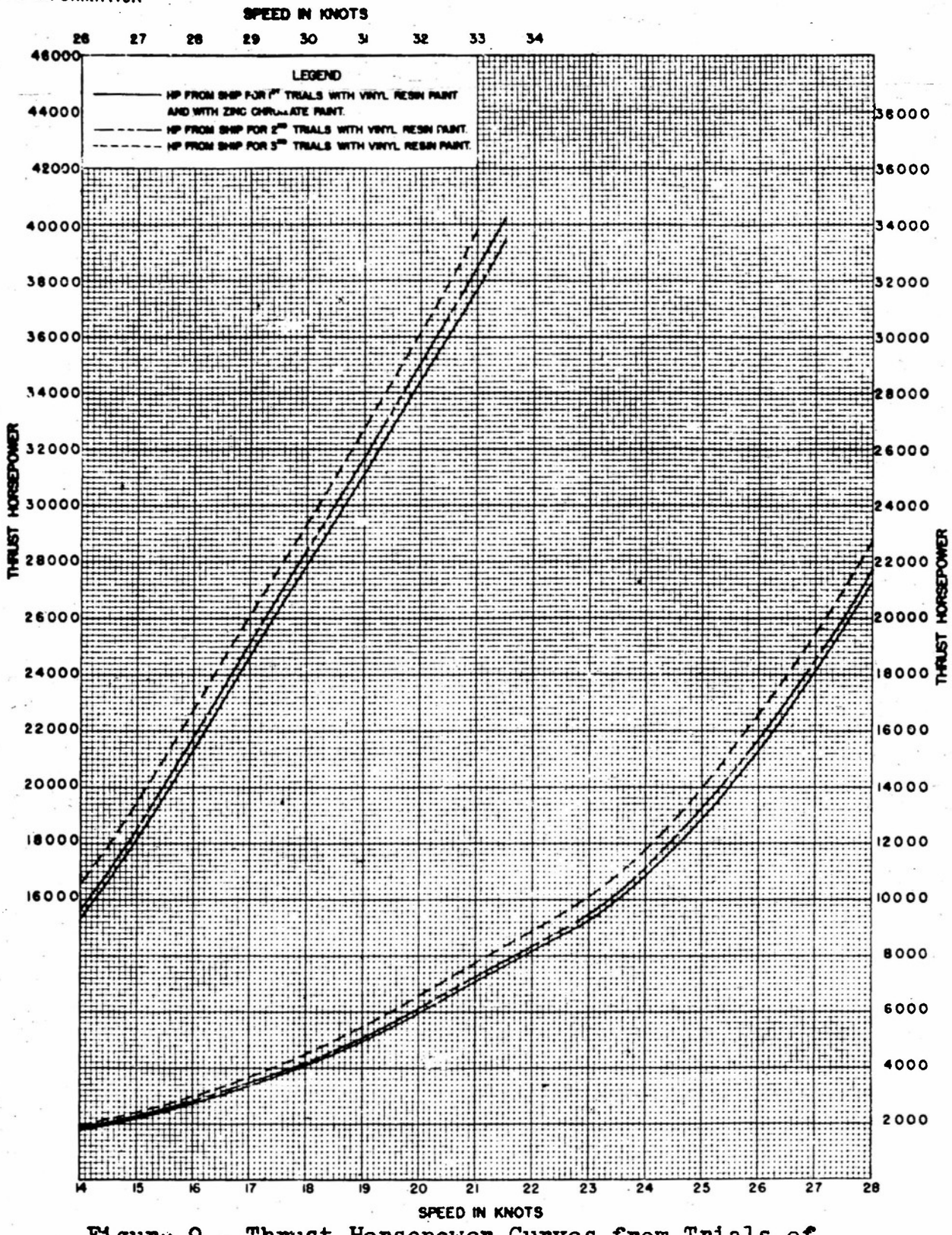

Figure 9 - Thrust Horsepower Curves from Trials of USS NORRIS (DDE 859) with Vinyl Resin & Zinc Chromate Paints Showing Trend of Data.

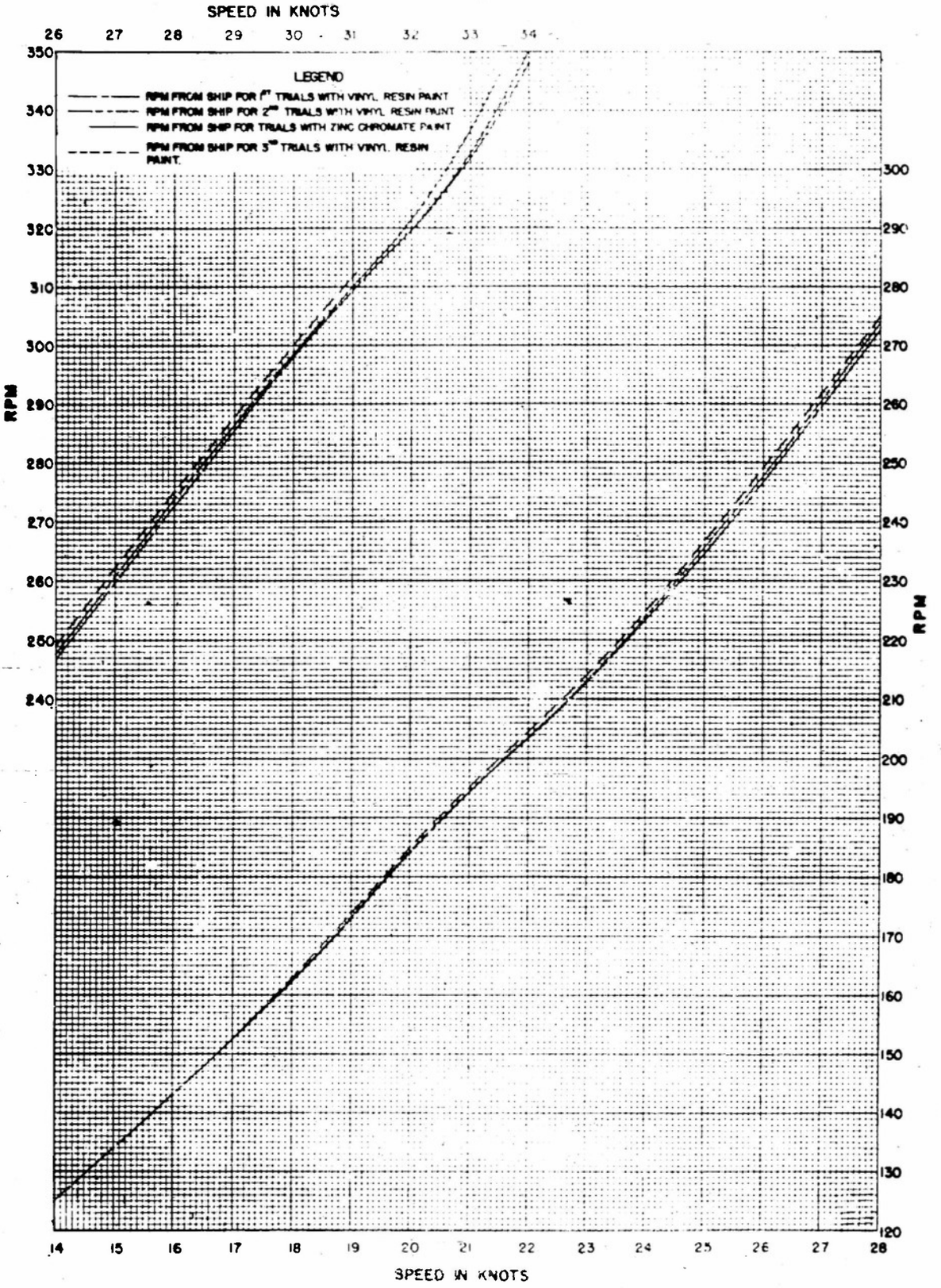

Figure 10 - RPM Curves from Trials of USS NORRIS (DDE 859) with Vinyl Resin & Zinc Chromate Paints Showing Trend of Data.

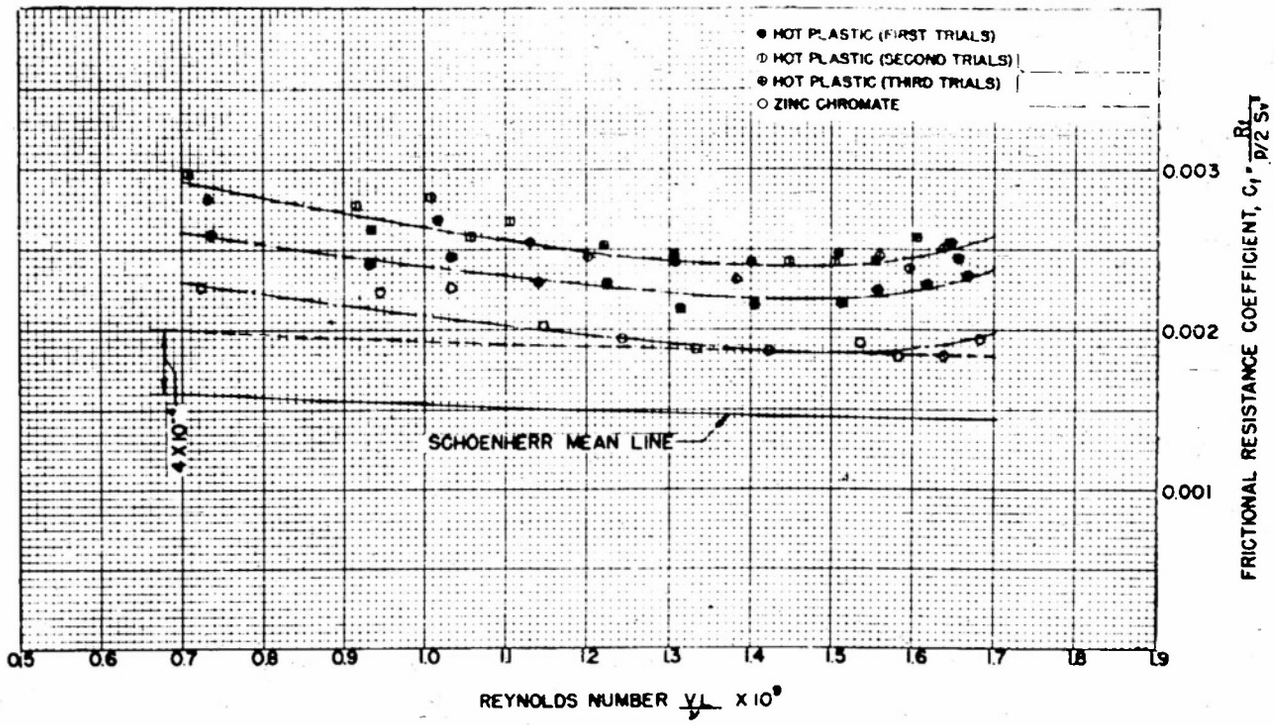

Figure 11 - Comparison of Frictional Resistance Coefficients for Zinc Chromate & Hot Plastic Paints from Trials of USS KEPPLER (DDE 765).

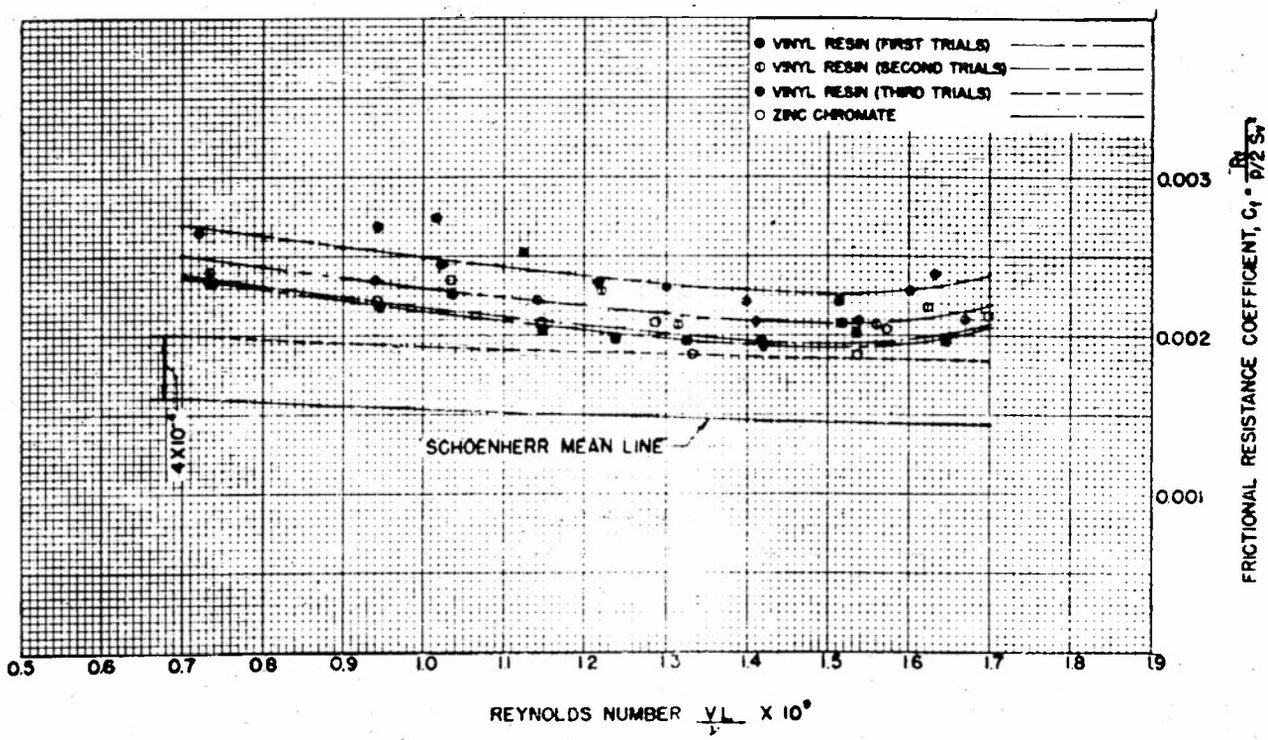

Figure 12 - Comparison of Frictional Resistance Coefficients for Zinc Chromate and Vinyl Resin Paints from Trials of USS NORRIS (DDE 859).

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